Characterization of 3691 Bede: Thermal Emission and Diameter, Albedo

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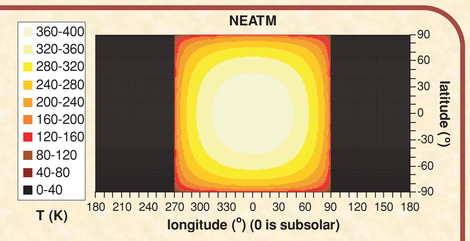
Objective & Approach

Characterization of NEAs provides important inputs into models for atmospheric entry, risk assessment and mitigation. The apparent brightness, thermal emission and surface composition are observed to change with the Sun-Target-Observer phase angle. Modeling the Thermal Emission yields coupled parameters of

Diameter *D*, Albedo *A,* and η (IR beaming parameter).

We discuss 11.6 µm data for 3691 Bede taken at α=42.5˚ from UKIRT on Mauna Kea. The thermal flux is too bright for an Albedo of ~0.6 derived from only shorter wavelength data from Spitzer Warm Mission and from WISE.

$$T_{\rm fit} = \left[\frac{(1-A)\,S_0}{r^2 \varepsilon \sigma \eta}\right]^{1/4}$$



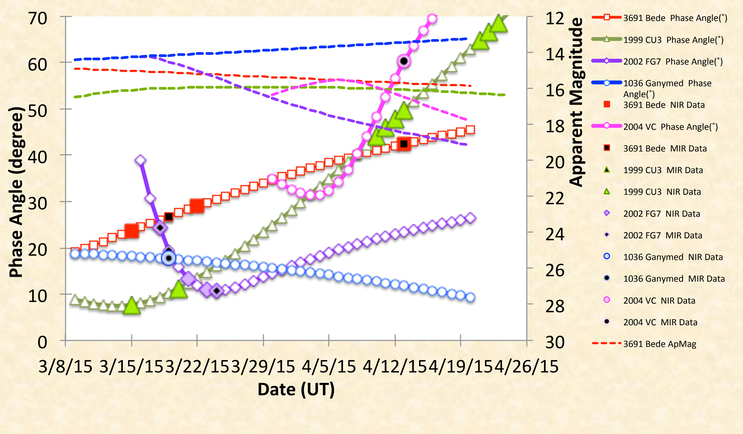
The beaming parameter (η) is a non-physical factor in the NEATM used to adjust the sub-solar point temperature.

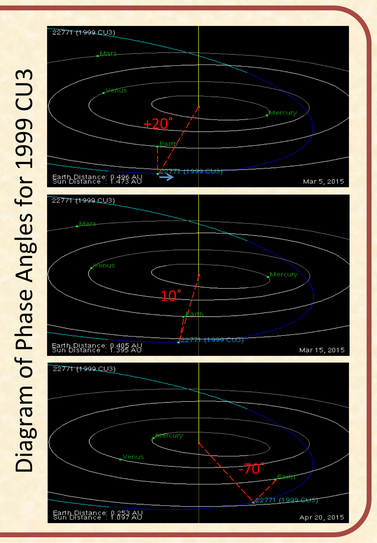
$$F_{\rm mod}(n) = \frac{\varepsilon D_{\rm eff}^2}{4\Delta^2} \int_{-\pi/2}^{+(\pi/2)} \int_{\alpha-(\pi/2)}^{+(\pi/2)} B[\lambda_n, T(\theta,\phi)] \cos^2\phi \cos(\alpha-\theta)\, {\rm d}\theta\, {\rm d}\phi, \quad (5)$$

$$D_{\rm eff}\,({\rm km}) = \frac{10^{-H_V/5}\,1329}{\sqrt{p_V}} \qquad p_V = \frac{A}{q}$$

Visible albedo pV is related to the Geometric Albedo A.

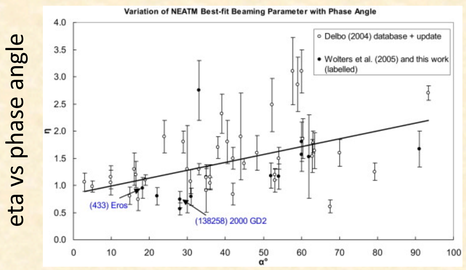
NEA Observations from UKIRT and IRTF: Near-IR and Mid-IR Data vs Date UT





UKIRT 11.6 µm photometry of 3691 Bede was obtained at 2 epochs, and at two wavelengths:
2015 Apr 13 alpha≈42.5˚ 122 ± 13 mJy 11.6µm
72 ± 12 mJy 8.8µm

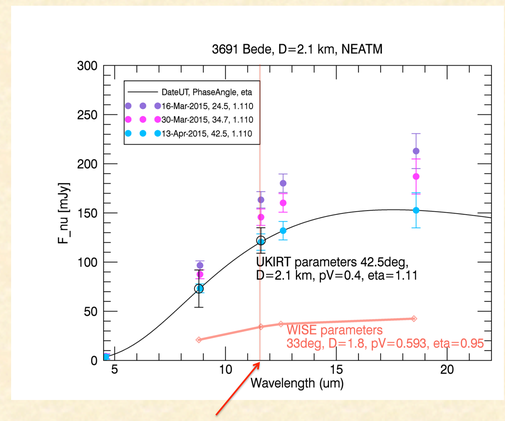
The flux is higher than WISE would predict, so the Albedo is lower and eta & Diameter larger.



eta vs phase angle

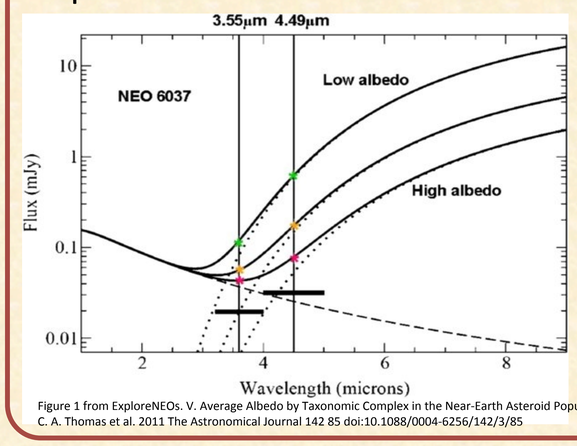
phase angle

3691 Bede: Thermal Emission is modeled to derive Diameter



11.6µm

Spitzer's Albedo for 3691 Bede is 0.63+0.38/-0.28



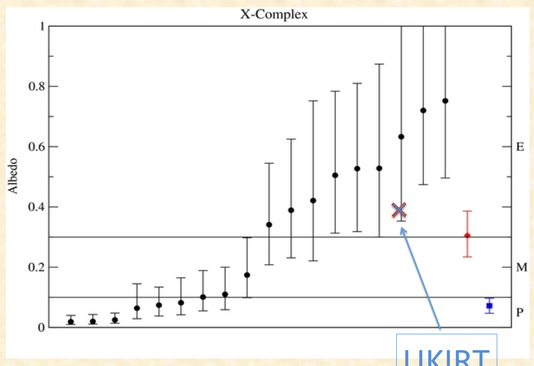
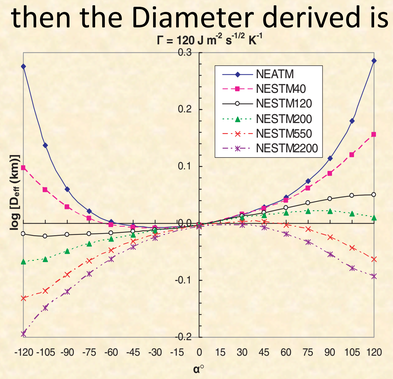
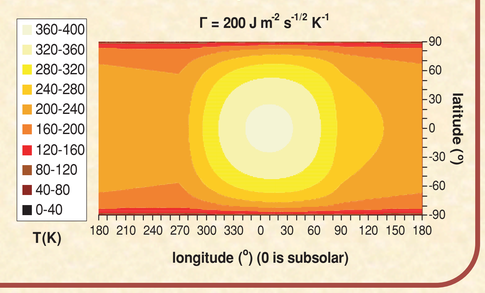


Figure 1 from ExploreNEOs. V. Average Albedo by Taxonomic Complex in the Near-Earth Asteroid Population C. A. Thomas et al. 2011 The Astronomical Journal 142 85 doi:10.1088/0004-6256/142/3/85

A thermal model with Night Emission may be the next step in modeling. NESTM was used to predict the uncertainties in Diameter for a 1km Diameter NEA at heliocentric distance of 1 AU. If the Thermal Inertia assumed is close to actual, then the Diameter derived is closer to 1 km.



Diameters derived at low phase angles ($\alpha \le 20^\circ$) are less affected by models and model parameters.



3691 Bede appears from UKIRT 11.6µm photometry to have a larger D_{eff} , lower albedo and cooler temperature (higher η) than prescribed by WISE data and by Spitzer warm data.

Data at multiple of phase angles (α) and heliocentric distances (*r*) can help determine *A*, η, and D_{eff}.

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